

AD-A154 274

AD A154274

B
R
L

SPECIAL PUBLICATION BRL-SP-46

TECHNICAL
LIBRARY

RACK FOR TEMPORARY STORAGE OF
105 MM HEAT AMMUNITION

Philip M. Howe

March 1985

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

US ARMY BALLISTIC RESEARCH LABORATORY
ABERDEEN PROVING GROUND, MARYLAND

Destroy this report when it is no longer needed.
Do not return it to the originator.

Additional copies of this report may be obtained
from the National Technical Information Service,
U. S. Department of Commerce, Springfield, Virginia
22161.

The findings in this report are not to be construed as an official
Department of the Army position, unless so designated by other
authorized documents.

The use of trade names or manufacturers' names in this report
does not constitute indorsement of any commercial product.



DEPARTMENT OF THE ARMY
UNITED STATES ARMY LABORATORY COMMAND
BALLISTIC RESEARCH LABORATORY
ABERDEEN PROVING GROUND, MARYLAND 21005-5066

REPLY TO
ATTENTION OF

SLCBBR-TB-E

27 May 1986

SUBJECT: Rack for Temporary Storage of 105 mm HEAT Ammunition

See Distribution

1. References:

a. Ballistic Research Laboratory Special Publication 46 entitled Rack for Temporary Storage of 105 mm HEAT Ammunition by Philip M. Howe, March 1986.

b. Message from USASC (PESC-PR), Fort Rucker, AL, subject as above, 251500Z November 1985 (NOTAL).

c. Message, USASC (PESC-PR), Fort Rucker, AL, subject as above, 011745Z May 1986 (NOTAL).

2. In response to reference c, it is recommended that the use of the rack as described in reference a and approved for use in reference b be temporarily suspended.

3. Recent tests by BRL indicate that a modification to the rack and its sandbagging is required to meet the 50-foot criteria for secondary fragments.

4. Detailed descriptions as to what modifications are required will be forthcoming as soon as safety approvals have been granted.

Robert B. Frey RF

ROBERT B. FREY
Acting Chief
Explosive Effects Branch

27 May 1986

SUBJECT: Rack for Temporary Storage of 105 mm HEAT Ammunition

Distribution:

Administrator, Defense Technical Info Center, ATTN: DTIC-DDA, Cameron Station, Alexandria, VA 22314

HQDA (DAMA-ART-M), Washington, DC 20310

Chairman, DOD Explosives Safety Board, ATTN: Dr. T. Zaker, COL O. Westry, Room 856-C, Hoffman Bldg 1, 2461 Eisenhower Avenue, Alexandria, VA 22331

Under Secretary of Defense for Research & Engineering, Department of Defense, Washington, DC 20301

Assistant Secretary of Defense (MRA+L) ATTN: EO&SP, Washington, DC 20301

HQDA (DAMA-CMS-CA/Mr. Lippi), Washington, DC 20310

HQDA (DAMO-NC/COL R. D. Orton), Washington, DC 20310

HQDA (DAPE-HRS), Washington, DC 20310

HQDA (DCSLOG/Elliott Seard), Washington, DC 20310

Assistant Secretary of Army (I&L), Department of the Army, ATTN: Lewis D. Walker, John Nash, Room 3E606, Pentagon, Washington, DC 20310

Commander, USA Safety Center, ATTN: PESC-Z, Fort Rucker, AL 36360

Commander, US Army Materiel Command, ATTN: AMCDRA-ST, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001

Commander, US Army Materiel Command, ATTN: AMCSF, 5001 Eisenhower Avenue, Alexandria, VA 22333

Director, AMC Field Safety Activity, Charlestown, IN 47111

Commander, Armament R&D Center, US Army AMCCOM, ATTN: SMCAR-TDC, Dover, NJ 07801

Commander, Armament R&D Center, US Army AMCCOM, ATTN: SMCAR-TSS, Dover, NJ 07801

Commander, Armament R&D Center, US Army AMCCOM, ATTN: SMCAR-LCM-SP, Dover, NJ 07801

Commander, Armament R&D Center, US Army AMCCOM, ATTN: SMCAR-IL, Dover, NJ 07801

✓ Commander, US Army Armament, Munitions and Chemical Command, ATTN: SMCAR-ESP-L, Rock Island, IL 61299

Commander, US Army Armament, Munitions and Chemical Command, ATTN: SMCAR-SF, Rock Island, IL 61299

Commander, US Army Aviation Research and Development Command, ATTN: AMSAV-E, 4300 Goodfellow Boulevard, St. Louis, MO 63120

Director, Benet Weapons Laboratory, Armament R&D Center, US Army AMCCOM, ATTN: SMCAR-LCB-TL, Watervliet, NY 12189

Director, US Army Air Mobility Research and Development Laboratory, Ames Research Center, Moffett Field, CA 94035

Commander, US Army Communications-Electronics Command, ATTN: AMSEL-ED, Fort Monmouth, NJ 07703

Commander, US Army Electronics Research and Development Command, Technical Support Activity ATTN: DELSD-L, Fort Monmouth, NJ 07703-5301

Commander, US Army Missile Command, ATTN: AMSMI-R, Redstone Arsenal, AL 35898

Commander, US Army Missile Command, ATTN: AMSMI-YDL, Redstone Arsenal, AL 35898

Commandant, US Army Missile Munitions Center and School, Redstone Arsenal, AL 35897

SLCBBR-TB-E

27 May 1986

SUBJECT: Rack for Temporary Storage of 105 mm HEAT Ammunition

Commander, US Army Tank-Automotive Command, ATTN: AMSTA-TSL, Warren, MI 48090
Director, US Army TRADOC Systems Analysis Activity, ATTN: ATAA-SL, White Sands Missile Range, NM 88002
Project Manager, Ammunition Logistics, ATTN: COL P. Greenberg, Mr. G. Goble, Dover, NJ 07801
Commandant, US Army Infantry School, ATTN: ATSH-CD-CSO-OR, Fort Benning, GA 31905
Commander, US Army Defense Ammo Center & School, ATTN: John Byrd, Savanna, IL 61074
Commander, US Army Development and Employment Agency, ATTN: MODE-TED-SAB, Fort Lewis, WA 98433
HQ, 8th US Army, ATTN: DJ-AM-SS (McDowell), APO San Francisco 96301
Commander, US Army Europe, ATTN: Chief of Staff, APO New York, NY 09403
Commander, US Army Europe, ATTN: AEAGA-SE, APO New York, NY 09403
Commander, US Army Europe, ATTN: G-4, APO New York, NY 09403
Commander, Naval Sea Systems Command, ATTN: SEA 64E (Mr. R. Beauregard), Washington, DC 20362
Commander, Naval Explosive Ordnance Disposal Facility, ATTN: Code 604 (Technical Library), Indian Head, MD 20640
Commander, Naval Surface Weapons Center, ATTN: R15 (J. Ward), Silver Spring, MD 20910
Commander, Fleet Marine Force, Atlantic, ATTN: G-4 (NSAP), Norfolk, VA 23511
Air Force Armament Laboratory, ATTN: AFATL/DLODL, Eglin AFB, FL 32542-5000
AFWL/SUL, Kirtland AFB, NM 87117
Director, US Army Material Systems Analysis Activity, ATTN: AMXSY-D, AMXSY-MP, H. Cohen, AMXSY-R, R. Simmons, Aberdeen Proving Ground, MD 21005-5071
Commander, US Army Test and Evaluation Command, ATTN: AMSTE-TO-F, Aberdeen Proving Ground, MD 21005-5055
Director, US Army Human Engineering Laboratory, ATTN: Jack Waugh, Aberdeen Proving Ground, MD 21005-5001
Commander, Chemical Research and Development Command, AMCCOM, ATTN: SMCCR-RSP-A, SMCCR-MU, SMCCR-SPS-IL, Aberdeen Proving Ground, MD 21010-5423

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER SPECIAL PUBLICATION BRL-SP-46	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) RACK FOR TEMPORARY STORAGE OF 105 MM HEAT AMMUNITION		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) PHILIP M. HOWE		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Ballistic Research Laboratory ATTN: AMXBR-TBD Aberdeen Proving Ground, MD 21005-5066		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 1L162618AH80
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Ballistic Research Laboratory ATTN: AMXBR-OD-ST Aberdeen Proving Ground, MD 21005-5066		12. REPORT DATE March 1985
		13. NUMBER OF PAGES 11
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution is unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) ammunition storage explosives safety distance 105 mm ammunition		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This special publication describes the construction and use of a rack for the temporary storage of 105 mm tank ammunition in densely populated areas, consistent with explosive safety criteria. The rack, when properly fabricated and barricaded, reduces the blast distance for inhabited buildings and the hazardous fragment distance to 50 feet. Approval for siting must be obtained, through channels, from the DOD Explosives Safety Board. It is intended that this document be used for construction guidance and as part of the documentation required for site approval.		

I. INTRODUCTION

The purpose of this report is to outline requirements for construction of a rack which can be used for temporary storage of M456 heat ammunition and other 105 mm tank ammunition in congested areas, consistent with DOD explosives safety criteria.

II. BACKGROUND

Reference is made to DOD 6055.9STD, DOD Ammunition and Explosives Safety Standards¹ and AR 385-64, Ammunition and Explosive Safety Standards,² which implements the Department of Defense Standards. Reference is also made to Ballistic Research Laboratory Memorandum Report entitled "Temporary Tank Ammunition Storage Facility"³ (in press).

Quantity-distance (Q-D) criteria for storage of conventional ammunition are designed to provide an appropriate level of protection against blast and fragment hazards. Explosives safety distance tables prescribe necessary separations and specify maximum quantities of the various classes of explosives permitted in any one location. These tables reflect acceptable minimum criteria for storage and handling of explosives. Such criteria provide reasonable safety within specified limits compatible with the risks of accidental explosion. Both the DOD 6055.9STD and the AR which implements this standard for Army installations and activities provide the opportunity for reduced hazard distances corresponding to reduced fragment and blast hazards, if it can indeed be demonstrated that the hazards are reduced. The burden of proof is upon the initiating activity to demonstrate an acceptable level of safety, however.

III. RATIONALE

The design of this storage rack was predicated upon the assumption that the rack should control explosion size, thus limiting the maximum credible event to some small fraction of the total stores, and should also control fragment hazards. The rack specified herein limits the maximum credible event to explosion or detonation of one warhead, with a corresponding blast radius (inhabited building distance) of 50 feet. With a 6 inch sand cover (as provided by one layer of sandbags), on the sides and roof, and with front and rear barricades, primary fragments are contained completely, kickouts are reduced to a minimum, and the fragment hazard radius, based upon one hazardous fragment per 600 square feet, is also less than 50 feet. Thus, when 105 mm M456 HEAT ammunition and other nonexplosive conventional antitank ammunition are stored, in their fiber shipping tubes, in the rack, warheads facing to the rear of the rack, the appropriate hazard distance is 50 feet, regardless of the total number of rounds stored at one site.

¹ DOD 6055.9STD, DOD Ammunition and Explosives Safety Standards, July 1984.

² AR 385-64, Ammunition and Explosive Safety Standards.

³ Philip M. Howe and David L. Collis, "Temporary Tank Ammunition Storage Facility," BRL-MR-3424 (in press).

IV. RACK DESCRIPTION

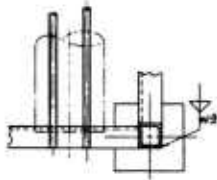
A shop drawing of the rack is shown in Figure 1. The rack consists of a steel frame made of angle iron, welded or bolted together, and steel spacer rods welded or bolted in position to hold the fiber tubes. The depth of the rack should be at least 45 inches deep, so that the complete round is contained within the rack. Spacing between tiers (vertical) must be at least 10 inches. Steel spacers must be positioned as in Figure 1, with separations of 6 inches, center to center, alternating with spacings of 3 inches, center to center. The support rods on 3 inch centers locate the shipping tubes with respect to each other. On the top of the rack, angle iron or rebar roof supports may be welded in place, as in Figure 1. A sheet of corrugated steel or fiberglass can be used as a rain cover and as a support for the sand cover. A sand cover of one sand bag thickness or 6 inches of loose sand is adequate for fragment protection. Note that cinder blocks, bricks, and concrete blocks are not acceptable for this application, as they serve as a source of secondary hazardous fragments. Sides of the structure are to be barricaded with a minimum of 6 inches of sand (one sandbag thickness), with the barrier joining the roof in such a way that continuous fragment protection is provided. If a natural barricade such as a berm or bank is not located behind the rack, then a sand barrier at least 3 feet thick will be placed behind the rack. The barricade may be placed in contact with the rack or it may be placed an arbitrary distance from the rack. If access to the rear of the rack is desired, a walkway space of at least 32 inches between the rack and rear barrier should be provided. In front of the rack, a barricade of sandbags (6 inches thick), cinder blocks, railroad ties, or other materials must be erected to provide protection from kickouts. The distance of this barricade from the front of the rack may be chosen for operational convenience. The minimum height of both the front and rear barricades must be equal to the top of the rack. An additional foot of height is required for both front and rear barricades for each yard of separation. Breadth of the rack is unlimited. The topmost tier of rounds shall not be more than 79 inches center of the round to ground to insure standing functional reach. This results in a round to round surface separation of 3 inches, which is sufficient to prevent round to round propagation of detonation. Significant deviations in design require approval by the DOD Explosives Safety Board. The rack, with sand covers and side barriers in place, is shown in Figure 2a. Several collocated racks are shown in Figure 2b. Note that the hazard radii are still 50 feet for the larger configuration.

V. USE OF THE RACK

The rack may be used to provide temporary storage of 105 mm tank ammunition, provided the rack is configured as described above, the ammunition is stored in the original shipping tubes, and the tubes are placed in the racks such that the warheads face towards the rear of the rack, provided the rack is located in excess of 50 feet from the nearest inhabited building, and provided express approval for siting is obtained from the DOD Explosives Safety Board.

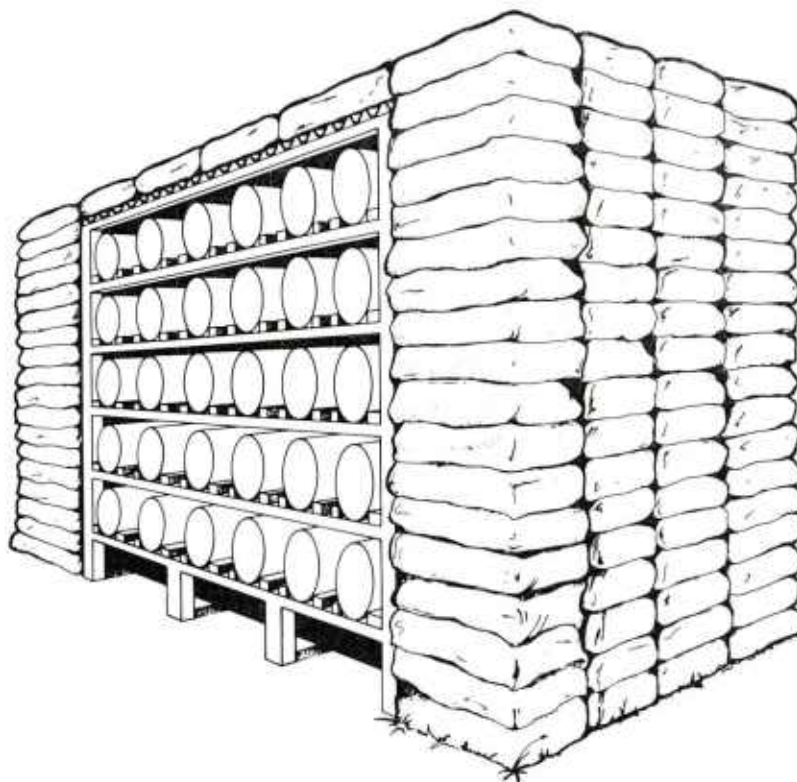
ACKNOWLEDGEMENTS

This work was sponsored by the DOD Explosives Safety Board. The final rack design was engineered by members of the US Army Human Engineering Laboratory's HELFAST Team, led by Mr. John D. Waugh. The shop drawing was prepared by members of the Engineering Design Division, USAHEL.



6

(a)



(b)

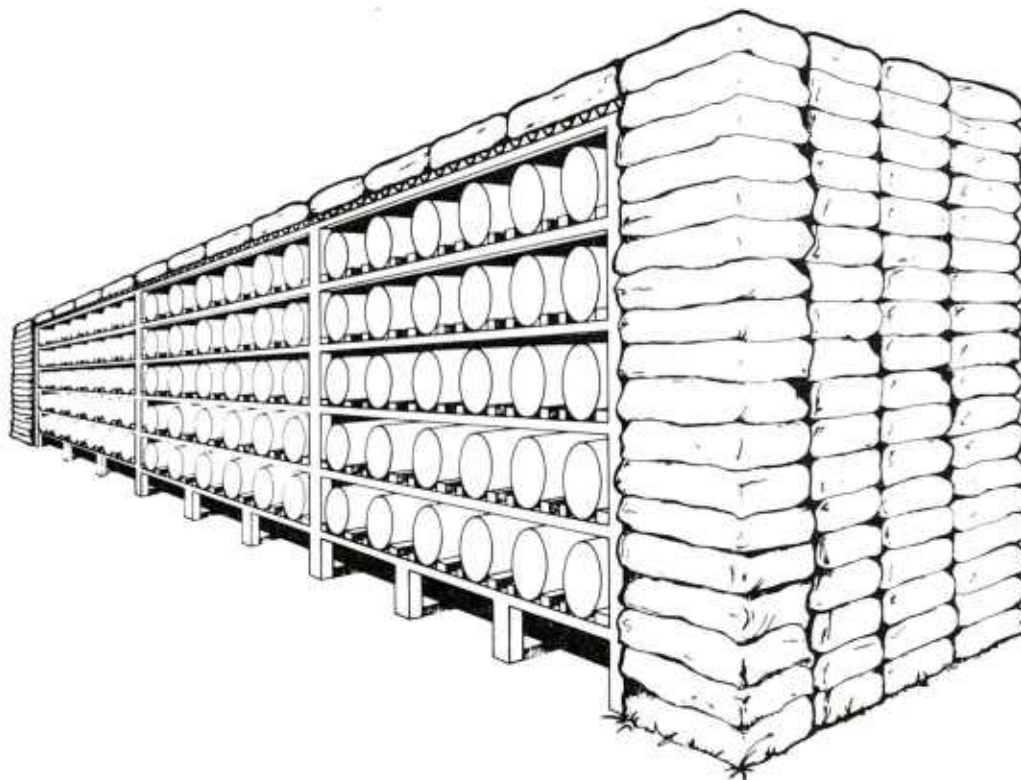


Figure 2. (a) Rack with Sand Covers and Side Barriers in Place.
(b) Several Collocated Racks.

DISTRIBUTION LIST

<u>No. of</u> <u>Copies</u>	<u>Organization</u>	<u>No. of</u> <u>Copies</u>	<u>Organization</u>
12	Administrator Defense Technical Info Center ATTN: DTIC-DDA Cameron Station Alexandria, VA 22314	2	Assistant Secretary of Army (I&L) Department of the Army ATTN: Lewis D. Walker John Nash Room 3E606, Pentagon Washington, DC 20310
1	HQDA DAMA-ART-M Washington, DC 20310	1	Commander USA Safety Center ATTN: PESC-Z Fort Rucker, AL 36360
5	Chairman DOD Explosives Safety Board ATTN: Dr. T. Zaker COL O. Westry Room 856-C Hoffman Bldg 1 2461 Eisenhower Avenue Alexandria, VA 22331	1	Commander US Army Materiel Command ATTN: AMCDRA-ST 5001 Eisenhower Avenue Alexandria, VA 22333-0001
1	Under Secretary of Defense for Research & Engineering Department of Defense Washington, DC 20301	1	Commander US Army Materiel Command ATTN: AMCSF 5001 Eisenhower Avenue Alexandria, VA 22333
1	Assistant Secretary of Defense (MRA+L) ATTN: EO&SP Washington, DC 20301	1	Director AMC Field Safety Activity Charlestown, IN 47111
1	Chief of Research, Development, & Acquisition Department of the Army ATTN: DAMA-CMS-CA, Mr. Lippi Washington, DC 20310	1	HQDA (DAPE-HRS) Washington, DC 20310
1	HQDA (DAMO-NC) ATTN: COL R. D. Orton Washington, DC 20310	1	Commander Armament R&D Center US Army AMCCOM ATTN: SMCAR-TDC Dover, NJ 07801
1	HQDA (DCSLOG) ATTN: Elliot Seard Room 1D563, Pentagon Washington, DC 20310	1	Commander Armament R&D Center US Army AMCCOM ATTN: SMCAR-TSS Dover, NJ 07801
		1	Commander Armament R&D Center US Army AMCCOM ATTN: SMCAR-LCM-SP Dover, NJ 07801

DISTRIBUTION LIST

<u>No. of</u> <u>Copies</u>	<u>Organization</u>	<u>No. of</u> <u>Copies</u>	<u>Organization</u>
1	Commander Armament R&D Center US Army AMCCOM ATTN: SMCAR-IL Dover, NJ 07801	1	Commander US Army Electronics Research and Development Command Technical Support Activity ATTN: DELSD-L Fort Monmouth, NJ 07703-5301
1	Commander US Army Armament, Munitions and Chemical Command ATTN: SMCAR-ESP-L Rock Island, IL 61299	1	Commander US Army Missile Command ATTN: AMSMI-R Redstone arsenal, AL 35898
1	Commander US Army Armament, Munitions and Chemical Command ATTN: SMCAR-SF Rock Island, IL 61299	1	Commander US Army Missile Command ATTN: AMSMI-YDL Redstone arsenal, AL 35898
1	Commander US Army Aviation Research and Development Command ATTN: AMSAV-E 4300 Goodfellow Boulevard St. Louis, MO 63120	1	Commandant US Army Missile Munitions Center & School Redstone Arsenal, AL 35897
1	Director Benet Weapons Laboratory Armament R&D Center US Army AMCCOM ATTN: SMCAR-LCB-TL Watervliet, NY 12189	1	Commander US Army Tank Automotive Command ATTN: AMSTA-TSL Warren, MI 48090
1	Director US Army Air Mobility Research and Development Laboratory Ames Research Center Moffett Field, CA 94035	1	Director US Army TRADOC Systems Analysis Activity ATTN: ATAA-SL White Sands Missile Range, NM 88002
1	Commander US Army Communications- Electronics Command ATTN: AMSEL-ED Fort Monmouth, NJ 07703	2	Project Manager Ammunition Logistics ATTN: COL P. Greenberg Mr. G. Goble Dover, NJ 07801
		1	Commandant US Army Infantry School ATTN: ATSH-CD-CSO-OR Fort Benning, GA 31905

DISTRIBUTION LIST

<u>No. of</u> <u>Copies</u>	<u>Organization</u>	<u>No. of</u> <u>Copies</u>	<u>Organization</u>
1	Commander US Army Defense Ammo Center & School ATTN: John Byrd Savanna, IL 61074	1	Commander Fleet Marine Force, Atlantic ATTN: G-4 (NSAP) Norfolk, VA 23511
1	Commander US Army Development & Employment Agency ATTN: MODE-TED-SAB Fort Lewis, WA 98433	1	Air Force Armament Laboratory ATTN: AFATL/DLODL Eglin AFB, FL 32542-5000
1	HQ, 8th US Army ATTN: DJ-AM-SS (McDowell) APO San Francisco 96301	1	AFWL/SUL Kirtland AFB, NM 87117
1	Commander US Army Europe ATTN: Chief of Staff APO New York, NY 09403		<u>Aberdeen Proving Ground</u> Dir, USAMSAA ATTN: AMXSY-D AMXSY-MP, H. Cohen AMXSY-R, R. Simmons
1	Commander US Army Europe ATTN: AEAGA-SE APO New York, NY 09403		Cdr, USATECOM ATTN: AMSTE-TO-F Cdr, USAHEL ATTN: Jack Waugh
1	Commander US Army Europe ATTN: G-4 APO New York, NY 09403		Cdr, CRDC, AMCCOM ATTN: SMCCR-RSP-A SMCCR-MU SMCCR-SPS-IL
1	Commander Naval Sea Systems Command ATTN: Mr. R. Beauregard, SEA 64E Washington, DC 20362		
1	Commander Naval Explosive Ordnance Disposal Facility ATTN: Technical Library, Code 604 Indian Head, MD 20640		
1	Commander Naval Surface Weapons Center ATTN: J. Ward, R15 Silver Spring, MD 20910		

USER EVALUATION SHEET/CHANGE OF ADDRESS

This Laboratory undertakes a continuing effort to improve the quality of the reports it publishes. Your comments/answers to the items/questions below will aid us in our efforts.

1. BRL Report Number _____ Date of Report _____
2. Date Report Received _____
3. Does this report satisfy a need? (Comment on purpose, related project, or other area of interest for which the report will be used.) _____

4. How specifically, is the report being used? (Information source, design data, procedure, source of ideas, etc.) _____

5. Has the information in this report led to any quantitative savings as far as man-hours or dollars saved, operating costs avoided or efficiencies achieved, etc? If so, please elaborate. _____

6. General Comments. What do you think should be changed to improve future reports? (Indicate changes to organization, technical content, format, etc.) _____

CURRENT ADDRESS	_____
	Name

	Organization

	Address

	City, State, Zip

7. If indicating a Change of Address or Address Correction, please provide the New or Correct Address in Block 6 above and the Old or Incorrect address below.

OLD ADDRESS	_____
	Name

	Organization

	Address

	City, State, Zip

(Remove this sheet along the perforation, fold as indicated, staple or tape closed, and mail.)